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BEFORE THE
POSTAL RATE COMMISSION
WASHINGTON, D.C. 20268-0001

POSTAL RATE AND FEE CHANGES, 2000

Docket No. R2000-1

DIRECT TESTIMONY OF
DONALD M. BARON
ON BEHALF OF THE
UNITED STATES POSTAL SERVICE

CONTENTS

	Page
Tables	iii
Library References	iv
Autobiographical Sketch	1
Purpose of the Testimony	3
PART 1	
Estimating Load-Time Elasticities	4
The Postal Service's Measure of Fixed Time at a Stop	7
The Stops Effect Measure Derived from the System-Wide Interpretation of the Load-Time Model	9
The Commission's Response	11
The Deciding Issue	14
The Deliveries Effect	19
PART 2	
Estimating Elasticities of Running Time With Respect to Actual Stops	22
PART 3	
The Calculation of New Street-Time Proportions	31
Why New Street-Time Data are Used to Allocate Accrued Street-Time Cost	32
How the ES Data are Applied to Derive New Street-Time Proportions	34
Evaluation of the New Proportions	36

CONTENTS (Continued)

ATTACHMENT A Page

Implications of Evaluating Elasticities at Average Volumes........................ 38

TABLES

Page

1. Average FY 1998 Predicted Load Time, $\bar{\hat{L}}$, Compared with Load Time Predicted at the Average Stop, $\hat{g}$(V/S).. 18

2. Quadratic and Interaction Model R-Squares.. 29

3. New Street-Time Percentages Derived From The Engineered Standards (ES) Database.. 35

LIBRARY REFERENCES

LR-I-157	Calculating Average Predicted Load Times and Predicted Load Times at Average Volumes
LR-I-158	The Calculation of Elasticities of Running Time with Respect to Actual Stops
LR-I-159	The Calculation of Street Time Proportions

Autobiographical Sketch

My name is Donald M. Baron. I have over 14 years experience in the study of postal economics. I have on several occasions provided assistance to the United States Postal Service in the preparation of testimony on topics relating to postal cost attribution and productivity. I also presented my own direct and rebuttal testimonies in the Docket No. R97-1 Rate Case. These testimonies presented proposals regarding the volume-variable city carrier and rural carrier costs, and the distribution of those costs across mail subclasses.

Examples of other postal studies I have conducted or supported include analyses of purchased transportation cost, mail processing labor productivities, post office box costs, and city carrier special-purpose route operations. I have also published articles for economics journals on various postal costing and productivity issues.

I am currently a Vice President with Foster Associates, Inc., an economics consulting firm in Bethesda, MD. Since the late 1960s, Foster Associates has assisted the Postal Service in a wide variety of studies to measure and analyze product and operations costs. Other areas of practice at Foster Associates include finance and valuation, litigation economics, regulatory economics, and resource economics.

Prior to joining Foster Associates, I worked for 9 years in the Washington, DC office of Arthur D. Little, Inc. where I also specialized in the analysis of postal costs, as well as the development of econometric models of postal demand and operational productivity.

From 1982 to 1984, I was a load research analyst with the Potomac Electric Power Company in Washington, DC. I developed and implemented econometric and other statistical analyses to estimate and forecast system loads and energy consumption.

From 1977 to 1982, I was an economist with the Economic Research Service of the United States Department of Agriculture, Washington, DC. I worked on projects to evaluate the efficiency of farm operations and help develop strategies for improvement, and to study long term trends in farm ownership and leasing patterns.

My educational background consists of a B.A. in Economics from Grinnell College (Phi Beta Kappa), an M.A. in Economics from the University of Michigan (Ann Arbor), and a J.D. from Washington University (St. Louis).

Purpose of the Testimony

This testimony is divided into three parts. Part 1 presents new analysis relating to the use of city carrier letter-route load-time regressions to derive load-time volume variabilities. Part 1 presents new justifications supporting the Postal Service's procedure for estimating load-time variabilities at a multiple delivery stop.

Part 2 further examines the issue of whether to use a basic quadratic model or a more complex quadratic model with numerous interaction terms in order to derive elasticities of city carrier running time with respect to actual stops. My new evaluation presents additional support for choosing the basic quadratic model.

Part 3 describes data collected from late 1996 through early 1998 in a new Postal Service field survey of carrier operations. It explains how these new data are used to calculate new estimates of the proportions of total street time that city carriers allocate to the loading, driving, street support, collection, foot/park & loop running time, and curb running time activities. Until recently, these time proportions had been derived from data collected in a 1986 field study of activities performed by a sample of 2,400 letter-route carriers. In that study, tallies were recorded to identify the specific functions that the carriers were conducting at the different points in time when they were paged by data collectors. The time proportions, referred to as the Street Time Survey (STS) percentages, were calculated as the percentages of tallies within the various functional categories.[1]

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[1] The 1986 Street Time Study is described in the Docket No. R87-1 Direct Testimony of Peter D. Hume, USPS-T-7 and Exhibit B.

Prior to its BY 1998 cost analysis, the Postal Service used these 1986 STS percentages to distribute aggregate annual accrued letter-route street-time costs across the load time, street support, driving time, and other functional categories. In producing its BY 1998 segment 7 spreadsheets, the Postal Service used the new street time proportions derived from the 1996-1998 carrier survey in order to distribute the street-time costs. The objectives and data collection procedures of this survey, and the database of carrier tallies it produced, are presented in the Direct Testimony of Lloyd B. Raymond.[2] Part 3 of my testimony explains the procedure that aggregates these tallies into the new estimates of the street-time proportions now applied in the segment 7 worksheets.

Part 1. Estimating Load-Time Elasticities

Docket No. R97-1 presents conflicting views regarding application of the regression equations that define load time at city carrier letter-route stops as functions of volumes delivered and collected and numbers of deliveries.[3] There are three such equations. The first applies to load time at single delivery residential (SDR) stops. This equation is:

$$LT = \alpha + \sum_{i}^{N} \gamma_i * R_i + \sum_{j}^{J} \delta_j * C_j + \sum_{k}^{K} \beta_k * V_k + \sum_{k}^{K} \beta_{kk} * V_k^2 + \sum_{k}^{K} \sum_{l}^{L} \beta_{kl} * V_k * V_l \qquad (1)$$

LT is load time at an SDR stop, R is a dummy variable representing receptacle type, C is a dummy variable representing container type, and V stands for volume by shape category, volume for accountables, and collection volume. There are three shape

[2] Docket No. R2000-1, USPS-T-13.

[3] See Docket No. R97-1, Opinion and Recommended Decision at 167-187, USPS-T-17, and JP-NOI-1.

categories: letters, flats, and parcels. γ and δ measure the effects of receptacle type and container type on load time. β_k, β_{kk}, and β_{kl} measure the response of load time to changes in volume. The β_{kk} coefficients account for quadratic effects, and the β_{kl} coefficients account for effects from interactions between different pairs of volumes.

The second and third load-time equations apply to multiple-delivery residential (MDR) stops and to business and mixed (BAM) stops. The general form is:

$$LT = \alpha + \sum_{i=1}^{N} \gamma_i * R_i + \sum_{j=1}^{J} \delta_j * C_j + \sum_{k}^{K} \beta_k * V_k + \sum_{k}^{K} \beta_{kk} * V_k^2 + \sum_{k}^{K} \sum_{l}^{L} \beta_{kl} * V_k * V_l +$$

$$+ \theta_1 * D + \theta_{11} * D^2 + \sum_{k}^{K} \phi_k V_k D \qquad (2)$$

The first line of this equation is the same as equation (1). In the second line, θ_1 and θ_{11} measure the linear and quadratic responses of load time to a change in deliveries (D), and the ϕ_k coefficients account for the interaction between deliveries and mail volumes.

The competing load-time analyses in Docket No. R97-1 proposed alternative methods for applying regression estimations of equations 1 and 2 to estimate volume-variable load-time costs. The parties to the debate did agree on three fundamental points. First, the initial step in deriving volume-variable costs is to calculate elasticities of SDR, MDR, and BAM load times with respect to the five volume terms. Second, the elasticity of load-time with respect to each volume term should be multiplied by the appropriate total accrued load-time cost to produce volume-variable load-time cost for that term, and this cost should be distributed to mail subclasses based on appropriate distribution keys. Third, the sum of the elasticities of load time with respect to the five volume terms, which is called the "elemental" load-time elasticity, accounts only for the effect of changes in volume at existing stops on load time at those stops. The cost analysis must, in addition, account for the increase in time that results from the increase in numbers of stops caused by volume growth. The calculation of this secondary "stops" effect of volume growth is called the coverage-related or fixed-time at stops analysis.

The debate among the R97-1 rate case participants begins here. Their disagreements relate first to how this "stops" or "coverage" effect should be measured. The approach recommended by Witness Antoinette Crowder applies a system-wide interpretation of the load-time model to derive aggregate-level measures of the stops effect.[4] The Postal Service's analysis rejects this derivation and proposes an alternative fixed-time at stop measure of the stops effect.[5]

A second dispute relates to the Postal Service's measurement of the "deliveries effect" at a multiple delivery MDR or BAM stop as the increase in load time caused by new actual deliveries that result from volume growth.[6] The Postal Rate Commission Decision rejects this measure, arguing that it double counts the deliveries effect.[7]

The remainder of this part of my testimony attempts to resolve these two remaining disputed issues. I present a new justification of the Postal Service's fixed-time at stop measure, and new arguments for why this measure of the stops effect is superior to the one derived through the system-wide interpretation of the load-time model. I also respond to Commission arguments opposing the Postal Service's measurement of the deliveries effect at an MDR or BAM stop.

[4] See JP-NOI-1, Attachment B at 1-7.
[5] See USPS-RT-1 at 17-22, 29-32
[6] See USPS-T-17 at 16-19 and 30-31, and USPS LR-H-139.
[7] See Docket No. R97-1, Opinion and Recommended Decision at 180-181.

The Postal Service's Measure of Fixed Time at a Stop

Beginning with its Docket No. R97-1 segment 7 cost analysis, the Postal Service has consistently asserted that the stops effect of volume on load time equals the increase in time that results from the accessing of a new stop. The Postal Service regards this block of time as independent of the amount and mix of volume delivered at that stop.

The procedure the Postal Service has implemented to measure this block of time was proposed in my Docket No. R97-1 Direct Testimony and explained in detail in an accompanying library reference.[8] To summarize, this procedure measures the stops effect as the minimum of the load times recorded during the 1985 load-time field test at stops receiving only one letter piece.[9] I estimated this minimum for each stop type as the average of the lowest quintile of these observed load times.

The initial justification for this approach was the need to measure the stops effect in a way that implements a key conclusion from the Docket No. R90-1 Recommended Decision. This Decision stated that the load time required to access a new stop is "independent of the amount of mail delivered at a stop," depending, instead, on whether "the stop receives mail at all." [10] Consistent with this definition, the Postal Service's stops effect measure is indeed independent of the amount and mix of volume delivered to each new stop.

An additional justification for this measure is that it is consistent with a key premise of the activity-based functional approach that produces the various accrued

[8] USPS-T-17 at 9-14, and USPS LR-H-140.
[9] See the Direct Testimony of Peter D. Hume, Docket No. R87-1, USPS-T-7 and Exhibit USPS-7C for a description of this 1985 field survey.
[10] Docket No. R90-1, Opinion and Recommended Decision at para. 3125.

cost pools of the segment 7 cost analysis. This functional approach allocates total accrued street-time cost across six major activities: load-time, driving time, curb running time, foot/park & loop running time, collection time, and street support. Each activity is defined as a distinct, separately identifiable carrier function or group of related functions. For example, driving time is the driving of vehicles on the park & loop portions of routes, and it includes motorized accesses at various stopping points, such as deviation deliveries and loop dismounts. Curb running time is the driving of vehicles on the curbline portions of routes, and it includes the accessing of SDR, MDR, and BAM delivery points. Collection time is the accessing and sweeping of street collection boxes. SDR, MDR, and BAM load time is the handling of pieces, bundles, and containers of mail at a household or business stop to prepare for putting mail into receptacles, the activity of putting mail into and collecting mail from the receptacles, and the activity of attending to customers when providing accountable services.

The total accrued cost calculated for each of these major activities equals the estimated percentage of time carriers spend conducting the activity times the total street-time cost. Thus each activity cost must be regarded as the cost of a separable, **explicitly defined** activity. As applied to load time cost, this requirement mandates that each of the two separately measured components of load time, namely, the elemental load time component, and the stops effect (or coverage-related load time) component, must also be regarded as distinct, separately identified actions.

The Postal Service's fixed-time at stop measure of the stops effect implements this activity-based requirement. It defines the stops effect as a distinct, separable part of the preparation function within the overall load-time activity. Specifically, it defines the stops effect as that part which is independent of the amount and mix of volume loaded at the stop.

Another key related point should also be clarified. The idea that some portion of a carrier's time spent loading mail at a stop can be fixed with respect to the amount and mix of mail loaded is unequivocally confirmed by functional analyses of other carrier activities. Both the Commission and the Postal Service agree, for example, that the **entire** portion of a carrier's running time spent accessing a stop is absolutely fixed with respect to the amount of mail delivered to that stop. Both the Commission and Postal Service running time models view this access time as being dependent solely on the numbers of actual stops made. If **all of** running time can be fixed with respect to the volume and mix of mail delivered to the stops, the far more conservative view that just a small **portion** of loading time, the portion called the stops effect, is similarly fixed with respect to volumes is clearly operationally sensible.

The rural carrier analysis further supports this conclusion. 52% of aggregate annual accrued rural carrier cost is, by definition, strictly fixed with respect to mail volume. This 52% portion equaled approximately $1.7 billion in FY 1998.[11] Given that so much of rural carrier workload is fixed respect to volume, it should be expected that some portion of city carrier loading time is likewise fixed with respect to volume.

The Stops Effect Measure Derived from the System-Wide Load-Time Model

In her Docket No. R97-1 Direct Testimony, Witness Crowder derived an alternative stops effect measure through a system-wide interpretation of the load-time model. This interpretation purported to define aggregate annual accrued load time for

[11] See Docket No. R2000-1, USPS-T-11, B Workpapers, W/S 10.0.1.

each stop type – SDR, MDR, and BAM - as a function of an estimated load time per stop times aggregate system-wide stops. This function is represented as:

$L = g(V/S) * S$ (4), where

L = aggregate annual system-wide accrued load time,

V = aggregate annual system-wide volume,

S = aggregate annual system-wide numbers of actual stops, with S = S(V),

V/S = average daily volume per actual stop, and

g(V/S) = load time at the stop that receives this average daily volume per stop.

The derivative of L in (4) with respect to V produces:

$$[(\partial L/\partial V)*(V/L)]*L = L*E_e + (L-(L*E_e))*E_s \qquad (5)$$

The left-hand side of this expression, $[(\partial L/\partial V)*(V/L)]*L$, is aggregate annual accrued load time (L) times the elasticity of L with respect to aggregate annual volume (V). Thus, $[(\partial L/\partial V)*(V/L)]*L$ is a proposed measure of aggregate annual volume-variable load-time cost. According to (5), this cost equals the sum of two components. The first component is the elemental load-time effect, defined as $L*E_e$, where E_e is the elasticity of load time with respect to volume at the stop that receives the average system-wide volume per stop, V/S. The second component is the residual, (L - $L*E_e$), times the elasticity of aggregate stops with respect to volume (E_S).[12] This product, $[L-(L*E_e)]*E_s$, is also Ms. Crowder's system-wide stops effect. It measures the increase in load time that occurs in response to an increase in actual stops caused by volume growth. $[L-(L*E_e)]*E_s$ is also referred to as volume-variable coverage-

[12] Docket No. R97-1, JP-NOI-1, Attachment B at 3-5.

related load time.

My Docket No. R97-1 Rebuttal Testimony critically assessed this derivation.[13] Rather than repeating this assessment in detail, I restate its main findings. The first relates to the definition of aggregate annual accrued load-time, L, as the product of load time at the stop that receives the average daily volume, g(V/S), and aggregate annual system-wide actual stops, S . This definition, presented in (4), is incorrect. The equal sign in (4) should be replaced by an inequality sign. The reason is straightforward. Undeniably, L does equal average daily load time per stop, $\bar{L}$, times S. That is L=$\bar{L}$*S. This is a simple tautology. However, the load-time regressions are non-linear. Therefore, $\bar{L} \neq g(V/S)$, and thus, $L \neq g(V/S)*S$.[14]

A second critical point is necessarily implied by this last result. Because $L \neq g(V/S)*S$, thus invalidating (4), the differentiation of (4) to produce the stops effect, $[L-(L*E_e)]*E_s$, in (5) is improper. $[L-(L*E_e)]*E_s$ is therefore an incorrect measure of the stops effect.

The Commission's Response

In its Docket No. R97-1 Decision, the Commission acknowledged that $\bar{L} \neq g(V/S)$ and that therefore $L \neq g(V/S)*S$. However, the Commission regarded g(V/S) as such a close "approximation" to $\bar{L}$ that it could likewise view g(V/S)*S as a close "approximation" to the product of true average load time, $\bar{L}$, and numbers of

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[13] Docket No. R97-1, USPS-RT-1at 17-22.

[14] The reason the non-linearity of the load-time regressions estimated from the 1985 LTV data set ensures that $\bar{L} \neq g(V/S)$ is that, where g is a function of a random variable, x, E(g) does not equal g(E(x)), unless g(x) is linear. See Russell Davidson and James G. MacKinnon, Estimation and Inference in Econometrics, Oxford University Press, 1993, at 800. See also my Docket No. R97-1 Rebuttal Testimony, USPS-RT-1 at 20-22.

stops, S. In other words, because g(V/S) was alleged to be a good approximation of $\overline{L}$, g(V/S)*S was said to be a good **approximation** of L.[15]

The Commission also asserted that this use of g(V/S) as an approximation of $\overline{L}$ was a "form of approximation" that I myself relied upon in my running time, access time, and load-time variability analyses. Indeed, the Commission claimed that the Postal Service generally adopts this approximation. The Postal Service, asserted the Commission, "evaluates functions at the average values of independent variables and assumes that the result is the average value of the function throughout its volume forecasting and cost variability analysis."[16]

The Commission lastly concluded that any "imprecision" in g(V/S) as an approximation of $\overline{L}$ and in g(V/S)*S as an approximation of L does not, in any event, nullify the derivation of the stops effect, $[L-(L*E_e)]*E_S$, from those approximations. The validity of this derivation, argued the Commission, "depends only on the validity of the assumption that a functional relationship exists between average load time per stop, E(g(x)), and average volume per stop, E(x)," where E(g(x)) is $\overline{L}$, and average volume per stop, E(x), is V/S from expression (4).[17] In other words, even though $\overline{L} \neq g(V/S)$, where g(V/S) is load time predicted by the load-time regression at the average volume per stop, V/S, the Commission asserted that some other functional relationship, call it $\overline{L} = h(V/S)$, nevertheless exists.

My first response is to agree that the acceptance or rejection of Ms. Crowder's system-wide load-time analysis depends on whether g(V/S) can be regarded as a close

[15] Docket No. R97-1, Opinion and Recommended Decision at 179, paragraph 3284.
[16] Ibid. at 179, paragraph 3285.
[17] Ibid at 180, paragraph 3286.

enough "approximation" of $\bar{L}$ to justify viewing g(V/S)*S as an acceptably close "approximation" to L. As I explain later, I reject the Crowder analysis precisely because g(V/S) is a very poor approximation of $\bar{L}$, due to substantial non-linearity in the load-time regressions.

However, the contention that I relied on the $\bar{L}$ = g(V/S) "form of approximation" in my own running-time, access-time, and load-time variability analyses is mistaken. Nowhere in these analyses did I state that average running times, access times, or load times are legitimately approximated by the times predicted by the relevant regressions at independent variable averages. It is equally erroneous to assert that because Dr. Bradley or I calculated elasticities at the average values of independent variables, we were necessarily implying that the resulting predicted dependent variable values closely approximate their corresponding expected values.

This issue of whether evaluation of an elasticity at the independent variable averages necessarily implies that the corresponding predicted dependent variable value equals the dependent variable average is critical to several Postal Service costing analyses besides the load-time analysis. Therefore, my rejection of this implication deserves further elaboration. I have included Attachment A to explain in greater detail why this implication is incorrect.

The claim that even though $\bar{L} \neq g(V/S)$ (where g is one of the load-time regressions), some other functional relationship, $\bar{L} = h(V/S)$, exists, is also incorrect. This claim asserts that an equation exists quantifying average load time over all stops as a function of average volume per stop. In reality, there is no alternative $\bar{L} = h(V/S)$ function to substitute for $\bar{L} \neq g(V/S)$. For a functional relationship to exist between $\bar{L}$ and V/S, each average volume per stop (V/S) must produce a unique corresponding value for average load time per stop ($\bar{L}$). Clearly, this requirement is violated. Each unique value for V/S can be produced by a virtually infinite number of differing allocations of mail volume across total, system-wide stops. Moreover, because of the non-linearity of the relationship between load time and volume at any one stop, each such allocation of volume across multiple stops produces a different value for $\bar{L}$. Thus, for any V/S, $\bar{L}$ will take on many differing values. Since a functional relationship requires that $\bar{L}$ equal only one value for each V/S, $\bar{L}$ cannot be a function of V/S.

The Deciding Issue

This review also reveals the importance of why $\bar{L} \neq g(V/S)$. As noted, the reason is the non-linearity of the regressions. One solution to the problem of how to formulate a valid system-wide interpretation of the **current** load-time model and to apply that interpretation to derive a legitimate stops effect measure is obvious. One must reestimate the load-time regressions as linear regressions. Short of this, any effort to derive a valid system-wide interpretation has only one other recourse. It must assume that the existing regressions are already close approximations to linear regressions. It must assume, specifically, that these approximations are close enough to justify viewing the current regressions as if they really **are** linear. This sudden linearity of the regressions would then ensure that $\bar{L}$ does equal $g(V/S)$, and that $L = g(V/S) * S$. The derivation of $[L-(L*E_e)]*E_s$ as the stops effect would be valid as well.

To summarize, Ms. Crowder's system-wide interpretation is valid only if the load-time regressions are linear. It can be regarded as valid only if the actual regressions are legitimately regarded as sufficiently close approximations to linear equations. This is a critical result, for the linearity assumption one necessarily, unavoidably adopts upon endorsing Ms. Crowder's interpretation also ensures that the stops effect measure, $[L-(L*E_e)]*E_s$, derived from that interpretation is a fixed-time at stops estimate. The reason is simple. If the load-time regression is linear, the residual $[L-(L*E_e)]$ equals the fixed regression intercept times aggregate annual stops, S. Thus, under linearity, $[L-(L*E_e)]$ is fixed with respect to volume at existing actual stops, and $[L-(L*E_e)]*E_s$ quantifies the increase in this fixed time that occurs solely in response to the increase in numbers of actual stops caused by volume growth.

For this reason, Ms. Crowder's system-wide interpretation of the load-time regressions actually confirms an important aspect of the Postal Service's stops effect analysis. The **valid** stops-effect measure as derived from Ms. Crowder's interpretation defines the stops effect as fixed-time at actual stops. The Postal Service's alternative measure does so as well. The two competing measures of the now common **definition** of the stops effect differ because the Postal Service rejects the linearity assumption necessary to make the system-wide measure valid. As noted earlier, the Postal Service instead calculates the stops effect as the average of the smallest amounts of time observed in the 1985 LTV tests for carriers delivering just one letter piece.[18]

Clearly, a key factor in choosing between this direct method and the competing system-wide method of estimating the stops effect is therefore whether the existing load-time regressions can legitimately be viewed as linear. If so, the residual-based

[18] Docket No. R97-1, USPS-T-17 at 9-15 derives the Postal Service's stops-effect measures.

measure is at least valid. If not, that measure is unequivocally incorrect, and the Postal Service's alternative is clearly preferable, as it is supported by empirical analysis, and as its validity does not depend upon the rejected linearity condition.

It is therefore fortunate that whether the regressions can justifiably be regarded as linear is easily resolved through a simple test. The closeness of the load-time regressions to linearity is quantified by the relationship between the average of the load times predicted by the regressions, E(g(x)), or $\bar{L}$, and the predicted load time at the average of the volumes, $\hat{g}$ (V/S). If $\bar{L} = \hat{g}$ (V/S), the regressions are exactly linear. The more $\bar{L}$ deviates from $\hat{g}$ (V/S), the greater is the non-linearity. Thus, the regressions can be regarded as linear only if the $\bar{L}$ values can be regarded as close approximations to the $\hat{g}$ (V/S) values.

This closeness can be directly measured. I implemented the following procedure to do so:

1. For each of the three stop types (SDR, MDR, BAM), I created a file containing the sample-weighted values for letters, flats, parcels, accountables, and possible deliveries obtained from all the CCS tests that were conducted at actual stops during FY 1998. Each record on each file contains the data from one CCS test.
2. Each record of letters, flats, parcels, accountables, and possible deliveries obtained from an FY 1998 CCS test was substituted for the appropriate variables in the SDR, MDR, or BAM load-time regression; average values from the 1985 load time test data set were substituted for collection volume, receptacle type, and container type, since these are not measured by the CCS.

3. Each substitution produced a corresponding predicted load time. All the substitutions combined produced total predicted load times for all the FY 1998 CCS tests conducted at actual stops for the given stop type. These predicted load times were then averaged to derive $\bar{L}$ for each stop type.
4. To derive the corresponding $\hat{g}$ (V/S) values, the average CCS volumes and possible deliveries per stop were calculated for each stop type. These averages were substituted into the appropriate load-time regressions along with averages from the 1985 load time test for collections, receptacle type, and container type to estimate the load times - the $\hat{g}$ (V/S) values - at the average-volume stops.

Table 1, below, presents these calculations. The results are definitive. Even under a liberal interpretation, $\bar{L}$ can arguably be regarded as close enough to $\hat{g}$ (V/S) to justify the linearity assumption only for the SDR regression. And such a liberal interpretation would be erroneous. The 2.61% discrepancy between $\bar{L}$ and $\hat{g}$ (V/S) derived from the SDR regression corresponds to a $21,000,000 discrepancy when inflated to include aggregate annual FY 1998 actual stops.

For the MDR and BAM regressions, there is no room for debate. $\bar{L}$ deviates substantially from $\hat{g}$ (V/S). The regressions cannot possibly be regarded as close approximations to linear regressions.[19]

[19] The estimates presented in Table 1 are derived in Docket No. R2000-1, USPS LR-I-157.

Table 1. Average FY 1998 Predicted Load Time, $\bar{\hat{L}}$, Compared with Load Time Predicted at the Average Volume Stop, $\hat{g}$ (V/S)

STOP TYPE	Number of Sets of FY 1998 CCS Test Volumes and Corresponding Load Times Predicted from the Regressions	The Average of these Predicted Load Times. $\bar{\hat{L}}$ (Seconds)	Load Time Predicted by the Regression at Average FY 98 CCS Values for Letters, Flats, Parcels, Accountables, and Deliveries, and at average 1985 LTV test values for the other right-hand side variables. $\hat{g}$ (V/S) (Seconds)	Percentage Deviation of $\bar{\hat{L}}$ from $\hat{g}$ (V/S)
SDR	205,028	8.408	8.633	- 2.61%
MDR	18,511	73.438	61.714	+ 19.00%
BAM	22,999	8.353	19.082	- 56.23%

These results confirm that g(V/S) is a poor approximation of $\bar{L}$ and that g(V/S)*S is a poor approximation of L. Moreover, $[L-(L*E_e)]*E_s$ cannot be viewed as a valid stops-effect measure.

The Postal Service's alternative fixed-time at stops measure is clearly preferable. It does not depend on the rejected linearity assumption. It directly measures the stops effect as an amount of time independent of the amount of mail delivered at a stop, and that varies only as the number of stops changes in response to volume. My Docket No. R97-1 testimonies, library references, and interrogatory responses comprehensively analyzed the empirical evidence gathered from the 1985 LTV study to derive the Postal Service's estimates of this fixed-time per stop. The Docket R97-1 record neither challenges the validity of this evidence nor refutes my procedure for converting it into final values.

The Postal Service has used these estimates to produce its BY 1998 segment 7 spreadsheets. In my view, the Postal Service has adopted a convincingly reasonable position. It has rejected a stops effect measure whose validity depends on a linearity assumption soundly contradicted by empirical evidence. It has refused to substitute this flawed measure for a fixed-time at stop measure that does not depend on the linearity assumption, that is derived from empirical analysis, and that explicitly implements the requirement of the activity-based costing structure that all accrued costs must apply to separate, distinct, definable activities.

The Deliveries Effect

As noted earlier, the Postal Service also views the deliveries variables in the MDR and BAM load-time equations as actual deliveries. It calculates the elasticity of load time at an MDR or BAM stop as the sum of the elasticities of load-time with respect to the five volume variables plus the product of the elasticity of load time with respect to deliveries and the elasticity of deliveries with respect to volume. This latter product is called the deliveries effect.[20]

The Commission's Docket No. R97-1 response to this procedure first simplifies the analysis by redefining the MDR and BAM form load-time equation as:

$$LT = g(v, AD) \qquad (6)$$

where v is volume at a single MDR or BAM stop, and AD is actual deliveries at this stop. The Commission then defines the equation

$$AD = f(v, PD) \qquad (7)$$

to account for the deliveries effect, where PD is possible deliveries at the stop.[21]

Given this condensed form of the model, the Postal Service's analysis of load time at the MDR and BAM stop would define the elemental load-time effect as $(\partial LT / \partial v) * (v / LT)$, and the deliveries effect as $(\partial LT / \partial AD) * (\partial AD / \partial v)$. The complete

[20] A more comprehensive explanation of the deliveries effect is presented at pages 16-23 of Docket No. R97-1, USPS-T-17.

[21] Docket No. R97-1, Opinion and Recommended Decision at 180-181.

elasticity of MDR or BAM load time with respect to volume would be the sum of these volume and deliveries effects stated in percentage terms:

$(\partial LT / \partial v) * (v / LT) + (\partial LT / \partial AD) * (\partial AD / \partial v)(v / LT)$.

The Commission's Docket No. R97-1 Recommended Decision rejects this derivation. Instead, it substitutes f(v, PD) from (7) into the right-hand side of (6) to redefine the MDR and BAM load-time equation as:

$$LT = g^*(v, PD) \qquad (8)$$

The Decision asserts that "all the effects of changes in volume, v, [on load time] that operate through the volume effect on actual deliveries" are accounted for in equation (8) through "the direct volume effects." I take this to mean that the single elasticity $(\partial LT / \partial v) * (v / LT) = (\partial g / \partial v) * (v / g)$ derived from (8) simultaneously accounts for both the elemental load-time effect and the deliveries effect of volume growth on load time at a multiple delivery stop.[22]

A review of the actual load-time regressions reveals the correctness of the Postal Service's alternative approach. Observe that equation (7) is a condensed version of the correct equation defining AD as a function of volume and PD. This equation, presented in Michael Bradley's Docket No. R94-1 Direct Testimony, is

$$AD = (1 - Exp^{\sum_{i=1}^{N} \beta_i * (V_i / PD)}) * PD \qquad (9)$$

where AD is actual deliveries, V_i is volume for mail subclass i, PD is possible deliveries, and β_i is the coefficient quantifying the effect on actual deliveries of changes in volume for subclass i.[23] Given this correct expression for AD = f(v, PD),

[22] Ibid. at 180-181.
[23] See the Direct Testimony of Michael D. Bradley, Docket No. R94-1, USPS-T-5 at 49-50.

and assuming, as in equation (7), that there is only one volume variable, v, instead of several v_i, the substitution of AD = f(v, PD) into the right-hand side of equation (6) produces:

$$LT = g(v,\ (1 - Exp^{\beta*(v/PD)})*PD) \qquad (10)$$

as the correct MDR and BAM load-time equation.

Equation (10) compels only one conclusion regarding load time elasticity. The load-time elasticity derived from equation (10) is:

$$(\partial LT/\partial v)*(v/LT) = (\partial g/\partial v)*(v/LT) + [(\partial LT/\partial AD)*(1/LT)*(\beta * v * Exp^{\beta(v/PD)})] \qquad (11)$$

Of course, this is exactly the elasticity proposed by the Postal Service. It is the sum of two distinct effects. The elemental effect is $(\partial g/\partial v)*(v/LT)$. The deliveries effect is $[(\partial LT/\partial AD)*(1/LT)*(\beta * v * Exp^{\beta(v/PD)})]$. Clearly, the first effect, $(\partial g/\partial v)*(v/LT)$, does not simultaneously account for the deliveries effect. It accounts only for the increase in load time resulting from increases in volume at deliveries that were "already accessed" prior to the volume increase. The second effect, $[(\partial LT/\partial AD)*(1/LT)*(\beta * v * Exp^{\beta(v/PD)})]$, must be separately accounted for to correctly account for the increase in load time that results from new actual deliveries caused by volume growth.

Evaluation of MDR and BAM regression results provides another useful perspective for understanding why this interpretation of the deliveries variable makes sense. At average values for all right-hand side variables, the partial derivative of MDR load time with respect to deliveries is approximately 3.8 seconds, and the partial derivative of load time in the BAM regression is approximately 10.1 seconds.[24]

Now the Postal Service regards the deliveries variable in each regression as actual deliveries. So its interpretation of these positive partial derivatives is straightforward. They measure the increase in time required to access a new delivery at a stop. In contrast, the view that the deliveries variables are strictly possible deliveries is incompatible with the existence of the two large positive partial derivatives of load time with respect to deliveries. According to this contrary view, the added delivery that causes the 3.8 second increase in MDR load time and the 10.1 second increase in BAM load time is a new possible delivery, not an actual delivery. But if the added delivery is only a possible delivery, how can it produce such large increases in load time? The only rational explanation for why load times increase by such substantial amounts when a new delivery is added to a stop is that the new delivery **is** being accessed. It is a new **actual** delivery.

Part 2. Estimating Elasticities of Running Time With Respect to Actual Stops

This second part of my testimony responds to the Commission's R97-1 Decision regarding two alternative models presented in that docket for splitting accrued letter route running time costs into variable access costs and fixed route costs. The first is the basic quadratic model. The second is a more complicated interactions model. The

[24] 3.8 seconds equals the elasticity of MDR load time with respect to actual deliveries, 0.4309, times average BY 1998 actual MDR deliveries, and divided by predicted MDR load time at this average and at the average BY 1998 volumes per MDR stop. 10.1 seconds equals the elasticity of BAM load time with respect to actual deliveries, 0.6468, times average BY 1998 actual BAM deliveries, and divided by predicted BAM load time at this average and the average BY 1998 volumes per BAM stop. These elasticities and average deliveries and volumes per stop are derived in Docket No. R2000-1, USPS LR-I-157

additional complexity results from interaction terms that produce separate slope coefficients for individual routes.

These competing models use data from the 1989 Curbline and Foot Access (CATFAT) study to produce alternative regressions that define running time as functions of numbers of stops made by carriers on letter routes.[25] Each model consists of one equation for each of three route groups: foot, park & loop, and curbline. Each equation produces elasticities of running time with respect to actual stops for the three stop types – SDR, MDR, and BAM. These elasticities define the so-called split factors, which divide total accrued route-access (FAT) and route-access (CAT) running time cost for each of the eight city carrier letter-route categories into accrued access costs and accrued route-time costs.

The details of how these alternative regressions are estimated and then applied to derive split factors are presented in my R97-1 Direct Testimony.[26] To summarize, the general form of the quadratic running time model is:

$$RUNTIME_{it} = \alpha_0 + \beta_1 * STOPS_{it} + \beta_2 * STOPS_{it}^{\ 2} + \sum_{i=2}^{n} \alpha_i * ROUTE_i + \sum_{t=2}^{5} \gamma_t * RUNUM_t \quad (12)$$

where there are n routes indexed by i, and 5 runs for each route, indexed by t. The variable definitions are:

$RUNTIME_{it}$ = total time taken to perform the t[th] run on the i[th] route.

$STOPS_{it}$ = number of actual stops made on the t[th] run on the i[th] route.

[25] The CATFAT study is described in R90-1, USPS-T-7 at 28-29. The CATFAT test implementation, field instructions, and data collection and recording are described in R90-1, Exhibit USPS-7A, and USPS LRs F-187 through F-190.
[26] See Docket No. R97-1, USPS-T-17 at 46-67.

$ROUTE_i$ = 1 if the run observation comes from the i^{th} test route, 0 otherwise.

$RUNUM_t$ = 1 if the run observation comes from the t^{th} run, 0 otherwise.[27]

The interaction model is:

$$RUNTIME_{it} = \alpha_0 + \beta_{1i} * STOPS_{it} + \beta_{2i} * STOPS_{it}^{\ 2} + \sum_{i=2}^{n} \alpha_i * ROUTE_i + \sum_{j}^{8} \sum_{t=2}^{5} \gamma_{jt} * RUNUM_t * RTYPE_j \qquad (13)$$

where there are n routes, indexed by i, 5 runs for each route, indexed by t, and 8 route types, indexed by j.[28] In addition:

$RUNTIME_{it}$ = the time taken to perform the t^{th} run on the i^{th} route.

$STOPS_{it}$ = actual stops made on the t^{th} run on the i^{th} route.

$ROUTE_{it}$ = 1 if the run observation was made on the i^{th} test route, 0 otherwise.

$RUNUM_t * RTYPE_j$ = 1 if the run observation was made on the t^{th} run conducted on a route of type j, 0 otherwise.

The critical difference between the two models is that the interactions model estimates n route-specific slope coefficients for both the STOPS and $STOPS^2$ variables, whereas the quadratic model estimates only one slope coefficient for each of these variables.

My R97-1 testimony endorsed the quadratic model for both operational and statistical reasons.[29] My current testimony confirms that choice. I do so by responding to the following three objections raised in the Commission's R97-1 Decision:

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[27] The quadratic regressions are derived in Docket No. R90-1, Exhibit USPS-7-B and USPS LR-F-192.
[28] See Docket No. R90-1, PRC LR-10.
[29] See Docket No. R97-1, USPS-T-17 at 51-67.

1. That my R97-1 Testimony purportedly uses the individual t statistics of the interaction model regressions to "sequentially discard apparently insignificant variables" from those regressions, and, moreover, that such a sequential process amounts to "'blind' stepwise significance testing."[30]
2. That the concern raised in my R97-1 Testimony about the negative signs of so many of the route-specific coefficients estimated for STOPS and the positive signs of so many route-specific coefficients for $STOPS^2$ is allegedly misplaced, since only the combination of the STOPS and $STOPS^2$ coefficients estimated for the different routes is important.[31]
3. That the statistical significance of the F-test values calculated for the three interaction model regressions purportedly mandates adoption of those regressions in place of the corresponding quadratic regressions.[32]

In response to the first contention, my R97-1 Testimony did not conduct stepwise significance testing. In the basic "forward selection" form of stepwise testing, the analyst adds new explanatory variables to the right-hand side of a regression one variable at a time.[33] My R97-1 testimony did not do this. It only reproduced the quadratic model regressions and the interaction model regressions exactly as they had already been estimated in Docket No. R90-1.

The confusion on this point perhaps results from my suggestion that the many

[30] Docket No. R97-1, Opinion and Recommended Decision at 164, para. 3245.
[31] Ibid. at 165-166, para. 3249.
[32] Ibid. at 162-167, paragraphs 3240-3241, 3243-3246, 3251.
[33] See, e.g., Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics, John Wiley & Sons, 1970, at 309.

route-specific coefficients in the interaction regressions that have low t statistics should not be used in the **calculation** of elasticities.[34] However, not using dummy variable interaction coefficients with high standard errors to derive elasticities is not the same as a decision to first **remove** route-specific STOPS and STOPS ^{2} variables that have low t statistics and to then **reestimate** the new, smaller model. Nowhere do I advocate the elimination of any subset of interaction terms from the Commission's interactions model and a subsequent reestimation on the remaining terms.[35]

In response to the second of the three contentions, I agree with the recommendation that all parties should focus on the **combination** of the STOPS and STOPS ^{2} coefficients estimated for the different routes in the three interaction model regressions. However, this focus yields a new reason to reject those regressions, for closer examination of the evidence shows numerous cases in which the combination of coefficients behaves contrary to common sense.

I demonstrate this result by calculating route-specific elasticities of running time with respect to actual stops for all routes that have separate coefficients in the interaction model regressions. To calculate each such elasticity, I first calculate each route's derivative of running time with respect to stops. Each derivative equals the given route's STOPS coefficient plus two times the product of its STOPS ^{2} coefficient and an estimated value for actual SDR, MDR, or BAM stops. This estimated value equals the given route's total possible stops as reported in the 1988 CATFAT data set

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[34] See Docket No. R97-1, USPS-T-17 at page 53.

[35] It is true that, as the Commission points out, I did not discard RUNUM coefficients having low t statistics from the quadratic regressions in using those regressions to estimate elasticities. In my view, these coefficients had so little impact on the elasticity calculation that it made little difference whether they were so used. However, if my use of these high-standard-error RUNUM coefficients is truly a concern, I would be more than willing to replace the current quadratic model elasticities with new elasticities calculated by excluding those coefficients from the calculation of predicted running times.

times the average BY 1996 coverage ratio for the given stop type. The route's elasticity is then calculated as its running time derivative times its estimated actual stops divided by the running time predicted for those actual stops.

The details of this calculation and its results are presented in USPS-LR-I-158. In summary, the results show that significant numbers of route-specific elasticities of running time with respect to actual stops are negative, unrealistically low, or unrealistically high. For example, 21.1% of the route-specific elasticities of curb route running time with respect to actual MDR stops are negative. 1.9% of these elasticities are positive but less than 0.10, and 5.0% of the elasticities are greater than 2.00. In addition, over 18.6% of the elasticities of park & loop running time with respect to MDR actual stops are negative, while 3.5% are positive but less than 0.10, and 7.5% are greater than 2.00.

In my view, the Postal Service has rationally concluded that given these numerous operationally infeasible elasticities, the interaction model's regression coefficients do not generally behave in a manner that could reasonably be expected. Thus the interaction regressions should be rejected in favor of the more plausible quadratic regressions. The quadratic regressions produce no negative elasticities, and no unrealistically low or unrealistically high positive elasticities of running time at actual stop levels implied by average coverage levels. At these coverages, the quadratic regressions produce only the expected positive elasticities falling within the 0.48 to 0.58 range.

The Postal Service is also justified in rejecting the conclusion that statistical significance of the F values calculated for the three interaction model regressions mandates substitution of those regressions for the quadratic regressions. Any such conclusion must arise from an inappropriate interpretation of the F-values. The Docket No. R97-1 Recommended Decision viewed the statistical signficance of those values as indicating first that all route-specific STOPS and $STOPS^2$ regressors (excluding the STOPS and $STOPS^2$ variables in the quadratic model) that the interaction model adds to the regressions are "jointly" significant. Moreover, although this joint significance implies only that at least one of the added route-specific regressors is non-zero, the Recommended Decision derived an additional key inference. It asserts that this joint statistical signficance of the route-specific regressors causes the quadratic model's exclusion of those regressors to fatally bias the quadratic model coefficients.

A fundamental problem with this interpretation is that no measures were used to actually quantify the **magnitude** of any biases in the quadratic regressions. The F values themselves don't do this; they establish only that some bias exists. The amount of bias could be small. The careful analyst is clearly justified in refusing to uncritically regard these biases as high enough to warrant serious concern, and in refusing to regard the F Test as a conclusive guideline that must dictate the correct choice among competing regression models.[36]

This justification is augmented by a realization that the available evidence suggests, if anything, the biases to be minimal. The quadratic regressions provide extremely good fits to the CATFAT data. The R-squares of the quadratic regressions

[36] See Potluri Rao and Roger L. Miller, Applied Econometrics, Wadsworth Publishing Company, 1971, at 35-36, 53-67 for an extensive discussion relating to the need to measure both the **degree** of bias in the coefficient estimates of a biased model and the precision of those estimates. The authors conclude that "how much bias a researcher is willing to accept or how much precision he can forego depends on the specific situation and on the seriousness of the consequences of the results; **no general guidelines can be set up**." Ibid. at 67 (Emphasis added).

are very high, ranging from 0.9471 for the curbline group, and 0.9619 for the park & loop group, up to 0.9682 for the foot group.

Table 2 compares these R-squares with the higher R-squares achieved by the interaction regressions.[37] The comparison shows that since the quadratic regression R-squares are already so high, the additional terms of the interaction model only increase the R-squares by modest amounts. Moreover, the numbers of such additional terms required to get these increases are extremely large.

Table 2. Quadratic and Interaction Model R-Squares

Route Group	Quadratic Model R-Square	Interaction Model R-Square	Percentage Increase in R-Square	Additional Variables in the Interaction Model
CURBLINE	0.9471	0.9852	4.0%	326
FOOT	0.9682	0.9920	2.5%	171
PARK & LOOP	0.9619	0.9872	2.6%	408

For example, for the Park & Loop group, the interaction model's addition of 408 new variables increases the R-Square by only 2.6 percent.

Skepticism is clearly warranted regarding the alleged magnitude of the bias in the quadratic model, when that model's fit is already so good that the addition of so many new regressors further improves the regression fit by such small amounts. Combined with the lack of evidence showing large biases in the quadratic model is the recognition that elimination of those biases requires increasing the variances of the coefficients. The additional interaction model variables reduce the precision of the coefficient estimates because they substantially reduce degrees of freedom.

[37] These R-squares are derived in Docket No. R97-1, USPS LR-H-141 and LR-H-142.

The Postal Service is correct in refusing to reject a model that is undeniably a good fit of the data and that produces running time elasticities that conform with operational reality, in place of a model that violates basic operational principals. The coefficients in the quadratic model make sense. They produce the expected positive elasticities of running time with respect to actual stops at average coverage levels. Many of the coefficients in the interaction regressions produce negative elasticities, or elasticities that, although positive, are unrealistically high or low.

Further, the relatively small numbers of coefficients in the quadratic model make the choice of method for converting the coefficients into one elasticity estimate per equation for each stop type relatively straightforward. The much greater numbers of coefficients in the interaction model greatly complicate the decision of how to calculate those elasticities, and no guidance is available showing which calculation method should be chosen.[38] The quadratic model also produces elasticities that conform to the Postal Service's and the Commission's shared conviction that elasticities should vary across route groups but not across stop types within each route group. The interaction model elasticities contradict that shared belief.[39] The quadratic model regressions have high R-squares. Moreover, although F tests suggest the regression coefficients are biased, no measures have been produced to quantify these biases in order to show they are serious enough to warrant the type of drastic corrective action produced by the interaction model regressions. On the contrary, the available evidence suggests that any such bias is small, and in any event, elimination of this bias must be paid for by loss of precision in the coefficient estimates.

[38] See Docket No. R97-1, USPS-T-17 at 57-60.
[39] See R97-1, USPS-T-17 at 63.

Part 3. The Calculation of New Street-Time Proportions

A major change in the segment 7 cost analysis introduced in the BY 1998 worksheets is the application of new estimates of the percentages of total letter-route carrier street time that are spent conducting the major street-time activities. These activities are loading, driving, route-access (FAT) running time, route-access (CAT) running time, collection, and street support. The new percentages replace the percentages derived from the 1986 Street Time Sampling study. These 1986 percentages had been used in all recent cost analyses through FY 1997.[40]

Loading is the handling of mail pieces and containers at the point of delivery and the performing of incidental customer services. Driving consists of driving postal vehicles on the park & loop portions of routes; it includes motorized accesses at all stops along these portions other than those that are made to collect mail from street boxes. Route-access (FAT) consists of walking along the foot and park & loop portions of routes. It also includes the accessing of all stops other than collection boxes. Route-access (CAT) is driving along the curbline portions of routes, and it includes the motorized accessing of all customer delivery points. The collection activity includes all work involved in obtaining mail from collection boxes. Thus, it includes vehicle and walking time spent in accessing the boxes as well as opening and sweeping the boxes.[41]

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[40] See Docket No. R87-1, USPS-T-7 and Exhibit B for a description of this 1986 study.

[41] See Docket No. R2000-1, USPS LR-I-1, Summary Description of USPS Development of Costs by Segments and Components, Fiscal Year 1998 for a comprehensive description of these activities and the methodologies used to measure their accrued and volume-variable costs.

Why New Street-Time Data are Used to Allocate Accrued Street-Time Cost

The data used to calculate the new percentages of time devoted to these street-time activities were collected in a field study called the Engineered Standards/Delivery Redesign project. The objectives, design, and implementation of this project are described in the Direct Testimony of Lloyd B. Raymond (USPS-T-13). One objective was to develop a database to support the development of improved time standards for carrier activities. Mr. Raymond's testimony and supporting documentation explain how data collectors used bar code scanners to record tallies identifying the route locations, delivery types (curbline, park & loop, foot, dismount, central), and activities (delivery/collection, travel, setup, unloading, etc.) conducted by carriers at successive six minute intervals of street time. Mr. Raymond's Library Reference, USPS-LR-I-163, describes the creation of a database consisting of 39,046 of these tallies collected between October 1996 and April 1998 from 340 routes located at 76 five-digit ZIP Codes. In constructing this database, Mr. Raymond added a variable defining the street-time activity category of each tally. The values of this variable are the loading, driving, route-access (FAT), route-access (CAT), collection, and street support functions that I defined in the previous paragraph.[42]

To distinguish this new data set from others used in my analyses, I refer to it as the Engineering Standards or ES data set. The principal reason for using it to produce the street-time percentages now used in the Postal Service's segment 7 worksheets is that it accounts for recent operational practices much more accurately than does the

[42] See USPS-T-13 Appendices D-F. See also USPS LR-I-163 for an explanation of how the database of tallies was compiled and formatted.

1986 data set that produced the previous street-time percentages. As Mr. Raymond's testimony points out, a key objective of the Engineered Standards/Delivery Redesign project was to obtain data needed to establish a new workload management system for city carrier routes. The data the project produced provide activity frequency and time-study information needed for the development of the new city carrier time standards, which, in turn, will help the Postal Service develop new route evaluation and route design procedures. Thus, the ES data set provides the best available source of observations describing what city carriers do in today's operating environment, how they perform each function, and what proportions of street time are devoted to the individual tasks.[43]

In contrast, the 1986 STS data cannot as accurately quantify today's city carrier time allocations. The 1986 environment had no DPS mail. The percentage of time carriers spent driving vehicles on routes was much lower in 1986 than in today's environment. According to the BY 1986 segment 7 worksheets, around 20% of total accrued BY 1986 street-time cost was generated on foot routes and 80% was generated on curb, business motorized, and park & loop routes.[44] According to the BY 1998 segment 7 worksheets, the percentage of cost on foot routes is now only 10%, with 90% of the cost generated on curb, business motorized, and park & loop routes.[45]

[43] The fact that the Engineered Standards/Delivery Redesign project has developed an up-to date operational database specifically intended to quantify the proportions of time carriers spend performing different tasks is one reason the A. T. Kearney Study recommended that the Postal Service consider using these data to update its segment 7 cost analysis. See A. T. Kearney, Data Quality Study, Technical Report # 4: Alternative Approaches For Data Collection, April 16, 1999, pages 53-56.
[44] Docket No. R87-1, USPS-T-7, Workpapers of Peter D. Hume at Worksheet No. 1A.
[45] Docket No. R2000-1, USPS-T-11, B Workpapers, W/S 7.0.4.1.

How the ES Data are Applied to Derive New Street-Time Proportions

To calculate the new street-time proportions, I input the ES database as a SAS data set into a mainframe SAS program.[46] The SAS program also reads in a file containing data from the Postal Service's City Carrier Route Master File (CRMF). These CRMF are used to define the route types of 336 of the total of 340 routes in the ES data set. The SAS program also calculates the total number of city carrier letter routes by route type that are located in each of the 76 ZIP Codes that contain the 336 ES routes. (Four of the 340 ES routes could not be located on the CRMF, and therefore the tallies collected for these 4 routes were not used in any subsequent calculations.)

After merging the CRMF and ES data sets, the SAS program defines weights for each of the ES routes. First, the program finds each ES route's route-type category. It then determines the total number of ES routes in that category and the total number of CRMF routes in that category for the 5-digit ZIP Code where the ES route is located. Each route's weight is then defined as the ratio of these total CRMF routes to the total ES routes.

Each weight accounts for the number of routes in a route type category within a given 5-digit ZIP Code that is represented by the given ES route. For example, if the ES route is one of 20 residential loop routes located in the ZIP Code, and the other 19 routes are not in the ES sample, the weight will equal 20. If, on the other hand, 5 out of the 20 routes are ES routes, the tally weight for each of the 5 routes will equal 20/5, or 4.

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[46] Docket No. R2000-1, USPS LR-I-159 presents a more detailed account of how the new street-time percentages are calculated.

The total number of tallies recorded by activity category for each ES route is then multiplied by that route's tally weight to estimate the corresponding total tallies for all the routes it represents. The resulting inflated tally count for the given ES route is thus directly proportional to the total population routes that it represents. This inflation adjustment ensures that each ES route properly represents the ZIP code from which it was selected.

The program next calculates the street-time percentages for the loading, driving, route-access (FAT), route-access (CAT), collection, and street support activities by dividing the sum of weighted tallies for each activity category by the gross total weighted tallies over all the activities combined. Separate sets of percentages are derived in this manner for the foot, business motorized, residential curb, residential park & loop, mixed curb, and mixed park & loop route types. These percentages, shown in table 3, are recorded in line numbers 9-14 of worksheet 7.0.4.1 of the B Workpapers presented in Docket No. R2000-1, USPS LR-T-11.[47]

Table 3. New Street-Time Percentages Derived From
The Engineered Standards (ES) Database

	FOOT	BUSINESS MOTORIZED	RESIDENTIAL CURB	RESIDENTIAL PARK & LOOP	MIXED CURB	MIXED PARK & LOOP
LOAD TIME	49.35%	30.59%	47.64%	35.27%	35.61%	33.22%
STREET SUPPORT	15.23%	16.77%	18.54%	17.79%	17.82%	12.81%
DRIVING TIME	2.16%	27.94%	8.85%	11.23%	20.09%	18.59%
ROUTE/ACCESS(FAT)	32.51%	20.00%	9.30%	33.20%	20.34%	32.88%
ROUTE/ACCESS(CAT)	0.44%	4.70%	15.59%	2.22%	5.43%	2.27%
COLLECTION	0.31%	0.00%	0.08%	0.29%	0.71%	0.23%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

[47] USPS LR-I-159 also shows how the percentages for the street support activity are divided into travel time and non-travel time portions.

Evaluation of the New Proportions

These new street-time proportions are substantially different from those presented in the Docket No. R97-1 Rate Case.[48] The new percentages are higher for load time and lower for the route/access categories than are the previous percentages. Moreover, because volume-variabilities are higher for load time than they are for route time, access time, and driving time, the increase in the load-time percentages results in a substantial increase in total volume-variable street-time cost above what that cost would have equaled under the previous street-time percentages.

The increase in the load time percentages and corresponding reductions in the route/access percentages are also consistent with changes in operational practices that have occurred since the 1986 STS Study. As noted earlier, the percentage of total street time spent on foot routes decreased substantially between BY 1986 and BY 1998, and the percentage of time on motorized (specifically, curb and business motorized) or partly motorized (i.e., park & loop) routes has increased. Since vehicle travel is so much faster than foot travel, it is to be expected that total route plus access time should account for a smaller percentage of total street time on motorized routes or the motorized segments of park & loop routes than it does on foot routes. Therefore, the increase in the proportion of total street time on motorized and partly motorized routes and corresponding reduction of time on foot routes should have caused an overall reduction in the total proportion of street time devoted to route and access activities, and an increase in the proportion spent in loading activities.

Other changes in operational factors that have also contributed to the increase in load time percentages since 1986 include continuing increases in mail volumes

[48] See Docket No. R97-1, USPS-T-5, WP B, W/S 7.0.4.1.

delivered to SDR, MDR, and BAM stops, and the introduction of DPS mail. Since load time volume variabilities are so much higher than volume variabilities for route, access, and driving time, increases in mail volumes since 1986 should have caused load time to increase at a faster rate than route, access, and driving time. Moreover, since the handling of DPS mail increases the amount of time carriers spend in preparing mail for delivery prior to inserting mail into receptacles, the introduction of DPS mail and its increasing percentage of letter-shaped volumes over the past several years should have further accelerated this increase in load time relative to other activities.[49]

To summarize, the new STS percentages are clearly more appropriate for allocating total accrued city carrier street time cost among activity categories than are the 1986 percentages. The new percentages are derived from a recent study, conducted from late 1996 through early 1998. This study was designed to define the specific activities carriers are performing today, and to measure precisely the proportions of time spent on each specific function. A key purpose of the study was to produce an objective assessment of how long it takes to perform various functions, and to use this assessment to help develop new time standards for route evaluation and design. The 1986 percentages describe the world of the mid-1980s, when there was no DPS mail, and when the proportions of the carrier's day spent on foot routes or foot portions of routes were much higher than they are today, and the proportions of time spent on motorized routes or motorized portions of routes were much less than today. The requirement that allocations of accrued street-time cost across activity category reflect as accurately as possible current operational reality clearly dictates application of the new proportions derived from the recent ES Study in place of the 1986 proportions.

[49] See Direct Testimony of Linda A. Kingsley, USPS-T-10, at page 27.

ATTACHMENT A
IMPLICATIONS OF EVALUATING ELASTICITIES AT AVERAGE VOLUMES

In the Commission's Docket No. R97-1 Recommended Decision it is claimed that the Postal Service "evaluates functions at the average values of independent variables and assumes that the result is the average value of the function throughout its volume forecasting and cost variability analyses...."[50] If correct, this claim would have a serious implication. It would imply that each time the Postal Service substitutes averages for volumes and other independent variables into equations in order to calculate elasticities, it unavoidably regards the resulting dependent variable value as the average workhour, or cost, per unit. Such a view would, in turn, force the conclusion that the product of this dependent variable value and the total population units must equal the correct total accrued cost. Moreover, since this product can deviate from the official accrued cost, as the load-time analysis has demonstrated, the idea that one is nevertheless constrained to regard this product as a legitimate accrued cost measure is clearly unacceptable.

It is therefore critical to refute the notion that evaluating an elasticity at the independent variable average necessitates viewing the resulting dependent variable value as the correct average hour or cost per unit. Fortunately, the Postal Service has already provided this denial in the Docket No. R90-1 Testimony of Michael Bradley. A brief summary of Dr. Bradley's response is therefore appropriate.

[50] Docket No. R97-1, Opinion and Recommended Decision at 179, paragraph 3285.

In this testimony, Dr. Bradley observes that the reason elasticity is measured at the average volume level is that such an elasticity measures cost variation at the most representative level of volume for a particular activity. Thus, Dr. Bradley observes that "evaluation of a cost function at the mean volume level provides, necessarily, an *unbiased* estimator of the true volume variability."[51]

Choosing the mean volume to measure the rate at which costs vary with volume does not, however, imply choosing the cost predicted at that mean volume as the expected value of the cost function. Indeed, we must explicitly reject this latter choice. The cost level predicted at the mean volume is one component of the elasticity formula. Moreover, as Dr. Bradley states, if this cost level is regarded as the expected cost level, the resulting elasticity is biased.[52] Thus, far from mandating that we regard the cost predicted at the average volume as the true expected cost, a decision to evaluate the elasticity at the average volume requires a definitive denial that the predicted cost equals expected cost. The Postal Service does therefore expressly deny that cost predicted at the average volume, or more generally, cost predicted at the average of all independent variables in the cost function, equals the expected cost level.

[51] Rebuttal Testimony of Michael D. Bradley, Docket No. R90-1, USPS-RT-2 at 10
[52] Ibid.